MINERAL RESOURCES BRANCH

MINING MATTERS

2005

REPORT ME 2005-2
ED. D. R. MACDONALD

THE WESTIN NOVA SCOTIAN HOTEL
NOVEMBER 9 AND 10, 2005

NOVA SCOTIA
Natural Resources

Honourable Richard Hurlburt
Minister

Peter Underwood
Deputy Minister

Halifax, Nova Scotia
2005

106-05103/

CONTENTS

Program ...*iv*

Thick Carboniferous Conglomerate Units with Arisaig Group Fossiliferous Clasts Formed in an Extensional Setting During Docking of the Meguma and Avalon Terranes, Isle Madame, Nova Scotia - S. *M. Barr, A. J. Boucot, W. D. Boyce, E. Force, E. Landing and C. E. White ...1*

The Joggins World Heritage Initiative: A Progress Report - *J. H. Calder....2*

Sampling Methodology for Investigation of Till-derived Placer Deposits in Former Gold Districts - *J. D. Chipman and R. F. Mills 3*

A Brief Overview of Groundwater Resources in Nova Scotia - *H. J. Cross and J. M. Drage ... 4*

Geology and Society: What is the Role of the Mineral Inventory? - *G. J. DeMont... 5*

Acadian Gold Corporation - *G. W. Felderhof.... 6*

Triggering Mechanisms of Debris Avalanches in the Central Cape Breton Highlands, Nova Scotia - *P. W. Finck....7*

Accessing Mineral Resources Branch Digital Geoscience Data and Information - *B. E. Fisher, J. C. Poole and J. D. MacNeill 8*

Nova Scotia Gold Grain Study - *T. A. Goodwin ... 9*

Structure and Predictability of Meguma Gold Deposits - *R. J. Horne ... 10*

Contact Metamorphism of the Halifax Formation, Halifax, Nova Scotia - *R. A. Jamieson, G. G. Hart, N. W. Tobey and J. P. Butler.... 11*

The North Mountain Basalt: a Walk Through a 201 Million Year Old Volcanological Paradise in the Jurassic Park of Southern Nova Scotia - *D. J. Kontak 12*

Mississippi Mourning: the Geological, Historical, Political and Cultural Ingredients of the Katrina Catastrophe - Why There is No "Big Easy Fix" - *E. Kosters 13*

Current Activities in Geological Mapping and Geochemistry - *M. A. MacDonald, T. A. Goodwin, R. J. Horne, R. D. Naylor, R. R. Stea and C. E. White ...14*

Drift Exploration Using Indicator Minerals and Till Geochemistry - *M. B. McClenaghan 15*

Preliminary Assessment of Tills at Kemptville, Yarmouth County, and Moose River and Lake Catcha, Halifax County, as Placer Gold Ore Sources - *R. F. Mills and J. D. Chipman..... 16*

A Summary of the Work Completed for the Nova Scotia Component of the 2003 to 2005 Targeted Geoscience Initiative Program - *R. D. Naylor, D. C. Brisco and P. S. Giles 17*

Naturally Occurring Radionuclides in Nova Scotia's Rocks, Water and Air - *G. A. O'Reilly 18*

Arsenic and Mercury Contamination from Historical Gold Mine Tailings in Nova Scotia - *M. B. Parsons, P. K. Smith, T. A. Goodwin, G. E. M. Hall and J. B. Percival.... 19*

GIS Database Construction for the Annapolis Valley Aggregate Project - *G. Prime 20*
The Legacy of Glacial Lakes in Nova Scotia - *R. R. Stea 21*
Characterization of Existing Sand Deposits in the Annapolis Valley Utilizing High-resolution LIDAR Digital Elevation Models - *A. Templin and T. L. Webster.....22*
Petrographic and Chemical Variations Through the Goldenville and Halifax Formations, Bear River, High Head, and Broad River Sections, Southwestern Nova Scotia - *R. M. Toole, S. M. Barr and C. E. White... 23*
Structure of the Western Cumberland Basin: Implications for Coalbed-methane Exploration - *J. W. F. Waldron and M. C. Rygel.....24*
The Application of High-resolution LIDAR Elevation Models for Understanding Landscape Evolution: an Example from the North Mountain, Nova Scotia - *T. L. Webster.... 25*
Preliminary Bedrock Geology of the Liverpool and Lake Rossignol Map Areas (NTS 21A/02 and 21A/03), Southern Nova Scotia - *C. E. White and R. M. Toole ... 26*

Program

Commonwealth Ballroom A and B, The Westin Nova Scotian Hotel, Halifax

Wednesday, November 9

8:30 am - 7:00 pm	Registration (Commonwealth Foyer)
8:30 am - 9:00 am	Coffee and Refreshments (Commonwealth B)
10:00 am - 9:00 pm	Displays Open (Commonwealth B)
8:55 am - 9:00 am	*Welcoming Remarks*, Peter Underwood, Deputy Minister, Nova Scotia Department of Natural Resources (DNR) Session Chair: Fenton Isenor, Mining Society of Nova Scotia
9:00 am - 9:20 am	*Overview of Trends in Canadian Exploration and Mining*, Peter Dimmell, President, Prospectors and Developers Association of Canada
9:20 am - 9:40 am	*Overview of Gold Mineralization in Nova Scotia*, Dan Kontak, DNR
9:40 am - 10:00 am	*Developing Gold Mines in Nova Scotia* , Will Felderhof, Acadian Gold Corp.
10:00 am - 10:20 am	*Orex Exploration Inc. Progress Report*, Jean Lafleur, Orex Exploration Inc.
10:20 am - 10:40 am	Break
10:40 am - 11:00 am	*The Surprising Placer Potential of Nova Scotia Tills in Former Gold Districts*, Ron Mills and Jared Chipman, DNR
11:00 am - 11:20 am	*Structure and Predictability of Meguma Gold Deposits*, Rick Horne, DNR
11:20 am - 11:40 am	*The Economic Impact of the Minerals Sector in Nova Scotia*, Bob Fraser, Gardner-Pinford Consulting Economists
11:40 am - 12:00 pm	*Of Coal, Gold, Kings, Legislatures and the General Mining Association - An Unusual History of Nova Scotia*, Howard Donohoe, DNR
12:00 pm - 2:00 pm	**Lunch, Harbour Suites A and B, Keynote Speaker Dr. Elisabeth Kosters (Acadia University)**: *Geological and Cultural Ingredients of the Katrina Catastrophe*, Cost $20
2:00 pm - 2:10 pm	*Welcoming Remarks*, Scott Swinden, DNR, Session Chair
2:10 pm - 2:40 pm	*The Legacy of Glacial Lakes in Nova Scotia*, Ralph Stea, DNR
2:40 pm - 3:10 pm	*Drift Exploration Using Indicator Minerals and Till Geochemistry*, Beth McClenaghan,' Geological Survey of Canada (Ottawa)
3:10 pm - 3:30 pm	*Nova Scotia Gold Grain Study*, Terry Goodwin, DNR
3:30 pm - 3:50 pm	Break
3:50 pm - 4:10 pm	*Accessing Mineral Resources Branch Digital Geoscience Data and Information*, Brian Fisher, DNR
4:10 pm - 4:30 pm	*Overview of Bedrock and Surficial Mapping Projects and Geochemistry*, Mike MacDonald, DNR
4:30 pm - 4:50 pm	*Overview of Mineral Deposit Projects*, Bob Ryan, DNR
5:00 pm	**Reception, hosted by the Hon. Richard Hurlburt, Minister of Natural Resources.** Cost $10

Thursday, November 10

8:30 am - 12:00 pm	Registration
8:30 am - 3:00 pm	Displays Open (Commonwealth A)
8:30 am - 9:00 am	Coffee and Refreshments
8:55 am - 9:00 am	*Welcoming Remarks*, Mike Cherry, DNR, Session Chair
9:00 am - 9:20 am	*A Brief Review of Groundwater Resources in Nova Scotia*, Heather Cross and John Drage, Nova Scotia Department of Environment and Labour
9:20 am - 9:50 am	*Mitigation of Coastal Hazards: Adaptation to Rising Sea Levels, Storm Surges, and Shoreline Erosion*, Charles O'Reilly, National Hydrographic Service
9:50 am - 10:20 am	*Arsenic and Mercury Contamination from Historical Gold Mine Tailings in Nova Scotia*, Mike Parsons, Geological Survey of Canada (Atlantic)
10:20 am - 10:40 am	*Naturally Occurring Radionuclides in Nova Scotia's Rocks, Water and Air*, George O'Reilly, DNR
10:40 am - 11:00 am	Break
11:00 am - 11:20 am	*Triggering Mechanisms of Debris Avalanches in the Central Cape Breton Highlands*, Phil Finck, DNR
11:20 am - 11:40 am	*Using LIDAR to Map the North Mountain Basalts*, Tim Webster, Centre of Geographic Sciences
11:40 am - 12:00 pm	*The North Mountain Basalt: a Walk Through a 201 Million Year Old Volcanological Paradise in the Jurassic Park of Southern Nova Scotia*, Dan Kontak, DNR
12:00 pm - 2:00 pm	**Lunch, Atlantic Ballroom, Keynote Speaker Tim Bernard, Mi'Kmawey Debert Cultural Centre:** *Tan Wetapesksi'k (Where we come from)*, Cost $20.
12:00 pm - 3:00 pm	Cash Bar, Commonwealth Ballroom A
3:00 pm	Conference Closed

Saturday, November 12

Post-conference Field Trip

A Visit to the Jurassic Park of Southern Nova Scotia: Volcanological Wonders of the North Mountain Basalt, Field Trip Leaders Dan Kontak and Rick Horne, Cost $10 (includes lunch).

Thick Carboniferous Conglomerate Units with Arisaig Group Fossiliferous Clasts Formed in an Extensional Setting During Docking of the Meguma and Avalon Terranes, Isle Madame, Nova Scotia

S. M. Barr[1], A. J. Boucot[2], W. D. Boyce[3], E. Force[4], E. Landing[5] and C. E. White

Isle Madame, located off the southern coast of Cape Breton Island, exposes anomalously thick, Carboniferous clastic sedimentary sequences that include over 5000 m of conglomerate. The thick conglomerate units occur in the Horton, Windsor, and Mabou groups. Also anomalous in the area are three long narrow belts of metamorphic rocks, together with voluminous chloritic microbreccia and minor semi-ductile mylonite, which are separated from the conglomerate-dominated sequences by faults. The angular relations between the cataclastic rocks and the thick dipping conglomerate units, combined with incorporation of cataclasite clasts in conglomerate and evidence of dip-slip faults within the basin, suggest an extensional setting, where listric normal faults outline detachment allochthons. Allochthon geometry requires two stages of extension, the older completed in early Windsor Group time (Viséan) and including most of the island, and a more local younger one completed in Mabou Group time (Namurian). These features are interpreted to have developed within a broad zone of Carboniferous dextral oblique convergence between the Avalon and Meguma terranes, in a localized transtensional basin within a transpressional regime. The two-stage history on Isle Madame allows us to see the deeper parts of one of the Horton-age extensional basins of the Maritimes basin, others of which have been described as half-grabens based on their shallower exposures.

Fossiliferous clasts occur in Carboniferous conglomerate in the Horton Group in western Isle Madame and in the Mabou Group in eastern Isle Madame. Most of the clasts examined (21 of 23) are calcareous siltstone and sandstone that contain Silurian-Lower Devonian faunas comparable to those in the Arisaig area, northern mainland Nova Scotia, although the lithologies are coarser grained and less calcareous than those of the Arisaig section. These middle Paleozoic faunas are well constrained to the Silurian (uppermost Llandovery through Pridoli) and lowest Devonian and are characteristic of those known from shallow siliciclastic-dominated platforms of the Avalon microcontinent in Wales and England. The remaining two clasts have abundant inarticulate brachiopod shells that indicate provenance from Middle Cambrian proximal marine facies on the Avalonian marginal platform. No clasts were found that are likely to have been derived from the Torbrook Formation, and thus from the Meguma terrane in southwestern Nova Scotia, as has been previously reported. The association of relatively large, reworked fossiliferous clasts in Carboniferous conglomerate on Isle Madame suggests local derivation from lower and middle Paleozoic units not presently exposed, although probably present as basement under the Carboniferous units.

[1]Department of Geology, Acadia University, Wolfville, NS B4P 2R6
[2]Department of Zoology, Oregon State University, Corvallis OR 97331, USA
[3]Geological Survey of Newfoundland and Labrador, PO Box 8700, St. John's, NL A1B 4J6
[4]Center for Mineral Resources, University of Arizona and US Geological Survey, Tucson, Arizona, 85721, USA
[5]New York State Museum, Madison Avenue, Albany, NY 12230, USA

The Joggins World Heritage Initiative: A Progress Report

J. H. Calder

With the naming of Joggins to Canada's Tentative List of future nominees for World Heritage designation in May 2004, preparations have begun in earnest to ready the site for nomination. With various government departments, agencies and municipal governments fully committed, restructuring of committees was undertaken in 2004 under the direction of Rhonda Kelly, Executive Director of the Cumberland Regional Development Association (CREDA). The Province of Nova Scotia invested $1.1 million in the development of the site in February 2005. With further support of the Nova Scotia departments of Tourism, Culture and Heritage; Natural Resources; and the Office of Economic Development, Jenna Boon, a native of Joggins, was named senior project manager and given the task of co-ordination of activities among various working groups. An ambitious goal has been set to meet the annual World Heritage nomination deadline of February 1, 2007.

Working committees report to an Advisory Board comprising senior representatives of government agencies that will play a role in the nomination, development and governance of the property, with Scott Swinden representing the Department of Natural Resources. Working committees include:

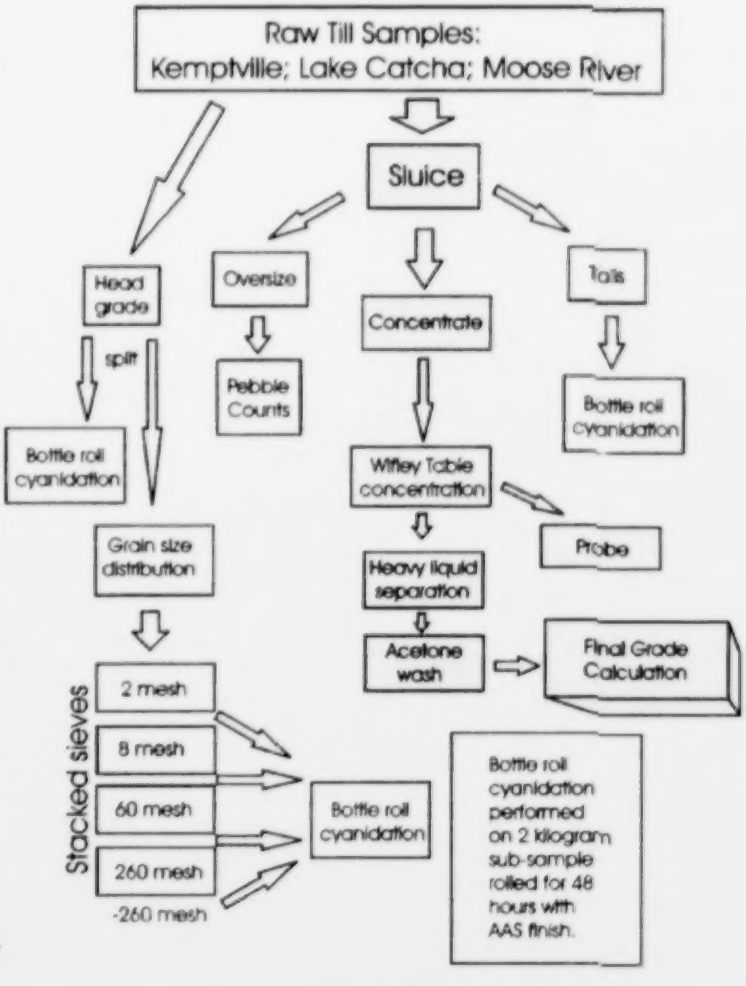
- Site Development, chaired by Marijo MacKay, Department of Tourism, Culture and Heritage,
- Communications, chaired by Ron Robinson, CREDA,
- Governance, co-chaired by Jenna Boon and Robert Ogilvie, Department of Tourism, Culture and Heritage,
- Nomination, chaired by John Calder, Department of Natural Resources, who also serves as scientific advisor.

During the summer and fall of 2005, requests for proposals were sought from firms for development of the interpretive facilities and shore access for the site. A consortium under the direction of WHW Architects of Halifax and including the design team of Design+Communications of Montreal was awarded the design contract for the site, which is being funded by the Atlantic Canada Opportunities Agency (ACOA) and is to be delivered early in 2006. The interpretive facilities are expected to be completed by the end of 2006 in anticipation of the February 2007 nomination deadline. The nomination dossier will be completed by September 2006 for pre-submission to senior staff at Parks Canada responsible for World Heritage matters in Canada. As the community prepares for the nomination, the Municipality of Cumberland County has made development of a land-use plan for the community its highest priority.

Sampling Methodology for Investigation of Till-derived Placer Deposits in Former Gold Districts

J. D. Chipman and R. F. Mills

Approximately 18,000 years ago, during the last glacial maximum, continental ice sheets that were up to 1 km thick covered Nova Scotia. During these times, the tops of the anticlines of the Meguma terrane, along with gold-bearing quartz veins, were removed and deposited as till when the glacier receded. In the summer of 2003 an adit unearthered in glacial till in the Tangier gold district led to further inspection of tills as placer sources. Further work and analysis carried out on this property, and preliminary work done on other properties, have revealed ore-grade gold levels. Three other sites were subsequently selected for evaluation, namely: Moose River, Lake Catcha and Kemptville.



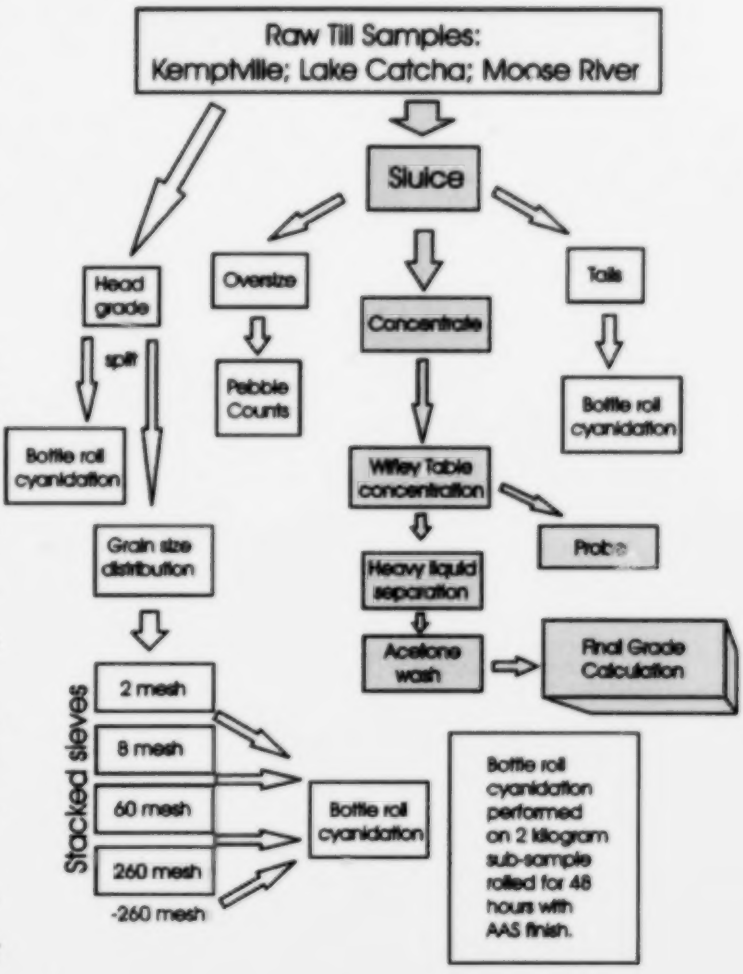
The discoveries have led to the development of a sampling methodology to evaluate other glacial deposits in Nova Scotia for possible gold and other base metal concentrations. The methodology involves field concentration with a Long-Tom sluice, further concentrated by a Wifley shaking table at the Dalhousie University's Mineral Processing Centre. To accompany the first assessments of this procedure, grains are probed with a scanning electron probe at Dalhousie University. This allows for investigation of placer commodities other than gold, such as tin or tungsten. A separate raw sample will be split and analyzed for head grade, and a tailing analysis is done for all sample sites. The raw split will have a size fraction analysis performed as well at the Dalhousie University's Mineral Processing Centre, to investigate resident gold fractions in the tills. Final analysis will be carried out using bottle roll cyanidation with an atomic absorption spectroscopy (AAS) finish. To establish a relative source of the material from each site a pebble count was carried out from the head grade of all samples.

Final grade calculations will be performed and stated in grade per cubic metre as well as in cubic yards. Preliminary results have been very encouraging for the sites selected thus far.

Sampling Methodology for Investigation of Till-derived Placer Deposits in Former Gold Districts

J. D. Chipman and R. F. Mills

Approximately 18,000 years ago, during the last glacial maximum, continental ice sheets that were up to 1 km thick covered Nova Scotia. During these times, the tops of the anticlines of the Meguma terrane, along with gold-bearing quartz veins, were removed and deposited as till when the glacier receded. In the summer of 2003 an adit unearthered in glacial till in the Tangier gold district led to further inspection of tills as placer sources. Further work and analysis carried out on this property, and preliminary work done on other properties, have revealed ore-grade gold levels. Three other sites were subsequently selected for evaluation, namely: Moose River, Lake Catcha and Kemptville.



The discoveries have led to the development of a sampling methodology to evaluate other glacial deposits in Nova Scotia for possible gold and other base metal concentrations. The methodology involves field concentration with a Long-Tom sluice, further concentrated by a Wifley shaking table at the Dalhousie University's Mineral Processing Centre. To accompany the first assessments of this procedure, grains are probed with a scanning electron probe at Dalhousie University. This allows for investigation of placer commodities other than gold, such as tin or tungsten. A separate raw sample will be split and analyzed for head grade, and a tailing analysis is done for all sample sites. The raw split will have a size fraction analysis performed as well at the Dalhousie University's Mineral Processing Centre, to investigate resident gold fractions in the tills. Final analysis will be carried out using bottle roll cyanidation with an atomic absorption spectroscopy (AAS) finish. To establish a relative source of the material from each site a pebble count was carried out from the head grade of all samples.

Final grade calculations will be performed and stated in grade per cubic metre as well as in cubic yards. Preliminary results have been very encouraging for the sites selected thus far.

A Brief Overview of Groundwater Resources in Nova Scotia

H. J. Cross[1] and J. M. Drage[2]

Use of groundwater as a resource depends on knowledge of the available quantity and quality, the ability to develop it in a cost-effective manner, constraints to its development, the ability to manage it in a sustainable manner, and the ability to protect it over both the short- and long-terms. A brief overview will be given of one aspect of the above, specifically groundwater quantity and quality, in relation to broad regional hydrostratigraphic units in Nova Scotia.

[1]Hydrogeo, 6 Auburn Drive, Dartmouth, NS B2W 3S6
[2]Nova Scotia Department of Environment and Labour, PO Box 697, Halifax, NS B3J 2T6

Geology and Society: What is the Role of the Mineral Inventory?

G. J. DeMont

Geology plays a significant role in the day-to-day lives of Nova Scotians, but only a small minority of the provincial population is cognizant of this fact. The deficiency in knowledge and recognition of this fundamental science can lead to poor land-use planning decisions, which in turn can have significant long term implications for the heath and safety of both communities and the environment.

Department of Natural Resources, the principal collector and compiler of geological data in Nova Scotia, has an inherent responsibility to disseminate this information to community decision-makers and planners. The question is, how do we accomplish this formidable task?

Many of Nova Scotia's rural communities are struggling to survive in a time when their populations are both shrinking and aging. There is a need for new economic opportunities to draw and hold young people in these areas. Small-scale mineral resource developments, such as that seen at the River Denys Marble Quarry, are one possible solution.

The posters will attempt to portray the relevance of one component of the geological data set to society, the Mineral Inventory, and the efforts made by Inventory staff in 2005 to deliver this information into the hands of community leaders and planners. They will also highlight a model that could be used as a rural economic development tool.

Acadian Gold Corporation

G. W. Felderhof[1]

Acadian Gold Corporation is a Canadian-based resource company exploring and developing gold projects in Nova Scotia, Canada. The company's principal focus is on the Nova Scotia goldfields where it is the dominant player, controlling five advanced gold projects and 34 others covering approximately 67 000 hectares (165,557 acres). Four of the advanced projects - Forest Hill, Beaver Dam, Goldenville and Tangier collectively host measured and indicated resources of 298,126 ounces of gold, plus inferred resources of 1,006,271 ounces of gold. All of these projects have scope for resource expansion. Economic modelling and scoping studies are underway and are expected in the fourth quarter of 2005.

Programs in 2005 will focus primarily on Beaver Dam, Forest Hill, Goldenville and Tangier, and will include diamond-drilling, environmental permitting and economic modelling.

Acadian Gold is bringing a new approach to the development of Nova Scotia gold deposits by pursuing a multiple mine, central processing, managing and servicing strategy. The company's mission is to become the dominant gold producer in Nova Scotia.

[1]President & CEO, Acadian Gold Corporation, Suite 1000, Cogswell Tower, 2000 Barrington Street, Halifax, NS B3J 3K1
Tel: 902-444-7779
Fax: 902-444-3296
Email: will@acadiangold.ca

Triggering Mechanisms of Debris Avalanches in the Central Cape Breton Highlands, Nova Scotia[1]

P. W. Finck

Debris avalanches result from a complex failure involving components of rock topple, rotational slippage, translational sliding and flow, with rates of movement from 0.5 to 30 m/s. Avalanches influence mineral exploration, mine development, forest harvest practices, the fresh water sport fishery and associated tourism.

Fifty-six avalanche events in the central Cape Breton Highlands were classified as: (1) low-mobility, (2) intermediate-mobility, (3) intermediate- to high-mobility and (4) high-mobility avalanches. The volume of debris increases from an average of 210 m^3 per event in low-mobility avalanches to an average of 5300 m^3 per event for high-mobility avalanches, with a resulting increase in the impact on the river system where the avalanche debris is discharged.

Dendromorphological evidence indicates that the frequency of debris avalanches increased by 1000% between 1980 and 1991 compared to the time period 1925 to 1979. Budwork defoliation, root decay and loss of soil strength are the prime local triggering mechanisms for debris avalanches. There is no correlation between the incidence of avalanches and road construction, ground disturbance, increased runoff due to logging, or earthquake. Average critical angles of 40° and an increase in precipitation during April 1980 and 1990 are regional controlling mechanisms of avalanches. Local trigger mechanisms inititate avalances independent of the overall regional slope instability.

[1]Funded by Nova Scotia Department of Natural Resources under the Canada - Nova Scotia Cooperation Agreement on Mineral Development 1990-1992

Accessing Mineral Resources Branch Digital Geoscience Data and Information

B. E. Fisher, J. C. Poole and J. D. MacNeil

The Digital Information Services group is responsible for developing and maintaining the Mineral Resources Branch (MRB) Geographic Information System (GIS) and associated databases, the NovaScan geoscience publications database, supplying digital data and services to clients and staff, and developing and maintaining the MRB Internet web site. The branch currently provides access to its geoscience information through several applications and is in the process of developing new ones.

NovaScan is the geoscience publications database for Nova Scotia and its offshore regions. A new enhanced Internet search interface is currently under development which will allow the public to access, search and download records contained in NovaScan. We hope to make this web site available by the end of the year. Currently NovaScan can be accessed through the Provincial Library's Internet-accessible NcompasS catalogue database at the following address: http://ncompass.library.ns.ca.

A Public Access GIS has been developed for the use of clients in the DNR Halifax Library. This is a user-friendly query and display system that uses a customized version of ArcView® 3.x to access a variety of spatially referenced, digital geoscience data on Nova Scotia. It can display and query data sets, overlay various themes of geoscience, topographic and land-use information, and plot the resulting maps in colour.

A collection of digital geology maps, databases and images of Nova Scotia (in DXF, ARC export, ArcView® shapefiles, TIFF, JPEG and in PDF format) has been developed, and is available for viewing or free download from the MRB web site (http://www.gov.ns.ca/natr/meb/pubs/pub3.htm).

In order to provide better descriptions and easier access to its digital products, the branch has written metadata for each of its digital products. A metadata search tool has been developed that will allow clients to search texturally and spatially for digital products, provide a description of the data, and a link to download the data. This will be done through a publicly accessible web site that should be available by the end of the year.

The Mineral Resources Branch has created several Internet Map Server (IMS) applications that allow the public to view, query, plot and download digital maps and databases over the Internet. Two applications were released in December 2004 and can be accessed at the following URLs: Nova Scotia Geoscience Maps, Databases and Images at http://gis2.gov.ns.ca/website/nsgeomap; and the Nova Scotia Mineral Resource Land Use Atlas at http://gis2.gov.ns.ca/website/mrlu27.

Nova Scotia Gold Grain Study

T. A. Goodwin

During the 2004 field season, twenty 10 kg till samples were collected in order to determine: (1) background concentrations of gold grains from across the province, (2) anomalous gold grain concentrations and the associated dispersal pattern from within a known gold district (Beaver Dam) and (3) the morphology of each of the grains recovered, an estimator for the distance of glacial transport. Sampling depths varied from approximately 1.5 to 2.5 m for regional till samples collected along roadside till exposures, while till samples associated with the detailed sampling program at Beaver Dam were collected from hand-dug till pits between 1.0 and 1.5 m in depth.

The morphology of gold grains recovered from till samples is, generally, classed into three categories: pristine, modified and reshaped. The distance of glacial transport from source can be estimated based on the gold grain morphology: pristine grains are indicative of minimal transport ranging from 0 to 100 m, modified gold grains have travelled in the order of 500 m, and reshaped grains have been transported in excess of 1000 m. There are, of course, exceptions.

Results for the fourteen 10 kg till samples collected from across mainland Nova Scotia indicate background gold grain concentrations range from 0 to 3 gold grains per 10 kg sample. The gold grains have been transported at least 1000 m from source, based on the reshaped morphology of the majority of the grains. Additional regional sampling throughout mainland Nova Scotia and Cape Breton Island is required to increase confidence and firmly establish background concentrations for the entire province.

Detailed 10 kg till samples collected along a 1400 m profile line from within the Beaver Dam Gold District, an area of known gold mineralization, indicate gold grain concentrations range from a low of 7 gold grains approximately several hundred metres up-ice from the Mill Shaft to a maximum of 161 gold grains approximately 300 m down-ice from the Mill Shaft. The farthest till sample collected approximately 1200 m down-ice from the Mill Shaft still contained 25 gold grains. The gold grain morphology indicates the majority (>80%) of the gold grains are dominated by pristine and modified gold grains, indicating proximity to source (<500 m). There is an increase in the percentage of reshaped gold grains in the down-ice, tail position.

In profile, a classic head and tail dispersal pattern is associated with gold mineralization from the Mill Shaft area. Additional down-ice sampling of till is required to establish the dispersal length of the anomaly, which is still open to the south. Additional sampling is also required up-ice to clearly establish the cut-off between background and anomalous gold grain counts.

Recently acquired 10 kg till samples from within the Kemptville and Tangier gold districts indicate the till in these districts also contain anomalous gold grain concentrations, typically several hundred grains per sample.

Structure and Predictability of Meguma Gold Deposits

R. J. Horne

Meguma lode gold deposits consist of 'saddle reef' vein arrays, where vein development is governed by flexural folding. Several stratabound and discordant vein types occur within these deposits. All major veins, however, can be shown to be synchronous and are kinematicly related to fold development. Variation seen in vein development between deposits largely reflects variation in fold geometry. Dependence of vein development on fold geometry allows predictability of vein occurrences within fold structures. For example, it has been long recognized that vein arrays are known to be restricted to the hinge zones of folds, particularly on steep limbs, and that the classic, large saddle veins occur in tight chevron style folds. Evaluation of regional fold geometries would provide targets for the discovery of new deposits.

Historical mining of Meguma deposits was limited to shallow depths; however, the relationship of vein arrays to fold geometry can be applied as a guide to presence of veins at depth. This approach has recently revealed a regular distribution of vein concentrations (ribbons) in the Bendigo Gold District of Australia that has been used in the successful delineation of previously unidentified saddle vein arrays below historical workings. Drilling has identified a regular distribution of veins at the Dufferin deposit and new veins have been recognized at the Goldboro deposit. Both of these deposits are classic chevrons and further veins are predictable below the tested levels. Similar evaluation of fold structures would provide predictability of vein occurrence at depth in other deposits.

Unfortunately, the distribution of gold within vein arrays may not be as predictable as the occurrence of veins, although some observations suggest systematic control on gold distribution. Several historical reports cite the intersection of veins, particularly bedding-parallel and angular veins, as important for gold distribution. Development of the Forest Hills deposit in the 1980s reported angular veins as controlling gold distribution and recent work by the author at the Mooseland deposit indicates notable high gold concentrations at intersections of bedding-parallel and angular veins. Recognition of such controls would be important to identifying ore zones within the vein arrays.

Contact Metamorphism of the Halifax Formation, Halifax, Nova Scotia

R. A. Jamieson[1], G. G. Hart, N. W. Tobey and J. P. Butler

The contact aureole developed on the southeastern margin of the Halifax Pluton (South Mountain Batholith) trends obliquely across the Halifax peninsula, at a high angle to regional structural trends in the Halifax Formation. Isograds have been mapped through the city of Halifax, based on exposures on the Dalhousie campus, Point Pleasant Park, the railway cut, and scattered outcrops and construction sites throughout the city. In the study area, the Halifax Formation includes two lithological units with different contact metamorphic assemblages. The Cunard member is a rusty, graphitic, black slate that underlies the region between the Dalhousie campus and the Armdale Rotary. The overlying "Bluestone" member (informal name) is a grey slate-siltstone unit, locally containing calcareous concretions, exposed in Point Pleasant Park, Williams Lake area, and adjacent regions. Prior to intrusion, the Halifax Formation was deformed into NE-SW-trending, regional upright folds associated with a strong slaty cleavage and chlorite-grade mineral assemblages. Contact metamorphism clearly overprinted both the regional low-grade mineral assemblage and the slaty cleavage, which is strongly annealed adjacent to the contact. Following intrusion, contact metamorphic assemblages were locally overprinted by brittle-ductile structures and retrograde metamorphism associated with flexural-slip folding. Sparse cordierite "spots" mark the outer limit of the contact aureole in both the Cunard and Bluestone members. The biotite-in isograd, which runs through the Dalhousie campus, is marked by the nucleation of biotite within distinctive chlorite + muscovite "stacks" that formed during regional metamorphism. Between the biotite-in isograd and the contact, metamorphic assemblages in both units are marked by increasing modal abundance of cordierite and biotite. However, there is a marked difference in the distribution of andalusite between the Cunard and Bluestone members. In the Cunard member, idioblastic chiastolite appears before biotite; its grain size and modal abundance increase gradually towards the contact. In the less aluminous Bluestone member, andalusite is present only in the immediate vicinity of the contact, where it forms xenoblastic ovoid aggregates, possibly after cordierite. Adjacent to the contact the regional slaty cleavage is annealed, and the characteristic assemblage andalusite + cordierite + K-feldspar, with rare fibrolite, is developed in both units. Corresponding changes occur in opaque mineral assemblages, with rutile and pyrite in the outer aureole replaced by ilmenite and pyrrhotite closer to the contact. Preliminary P-T estimates, including RSCM thermometry in graphitic slates, suggest that the biotite-in isograd developed at ca. 475°C and 2-3 kb, with temperatures at the contact reaching ca. 600°C. Although the Halifax Pluton is exposed only on the west side of the Northwest Arm, the distribution of isograds suggests that it may extend at shallow depth beneath the South End of Halifax.

Key words: contact metamorphism, isograds, metamorphic petrology, metamorphic textures, Halifax Formation

[1]Department of Earth Sciences, Dalhousie University, Halifax, NS B3H 3J5
beckyj@dal.ca

The North Mountain Basalt: a Walk Through a 201 Million Year Old Volcanological Paradise in the Jurassic Park of Southern Nova Scotia

D. J. Kontak

The 201 Ma North Mountain Basalt (NMB) of southern Nova Scotia, part of the globally significant Central Atlantic Magmatic Province (CAMP), outcrops as a prominent cuesta along the southern margin of the Bay of Fundy and is conformable with a basin fill sequence of underlying (Triassic) and overlying (Jurassic) terrestrial sedimentary rocks. CAMP formation was coincident with a global mass extinction terminating the Triassic period, hence the significance of these basalts. Eruption of the ca. 400 m thick, subaerial NMB sequence was rapid (few thousand years) and, by analogy with other large basalt provinces, was probably fed by large fissures, now dyke fields (?). Regional mapping of the NMB along its 200 km extent from Cape Split to Brier Island indicates the basalts are easily divisible into three laterally continuous, internally consistent, volcanological flow units referred to as the lower- (LFU), middle- (MFU) and upper- (UFU) flow units. Exceptional volcanological features are displayed along the almost continuous cliff faces bordering the Bay of Fundy and in numerous isolated quarries. The LFU (≤180 m) is a massive, medium-grained, dominantly holocrystalline basalt with well-developed polygonal jointing (i.e. columnar joints ≤2 m) of colonnade and complex entablature patterns. However, the upper ca. 10 m is finer grained and rarely intensely vesiculated. The LFU often contains layers of comb-textured, pyroxene-rich ($En_{10}Fs_{78}Wo_{12}$), mafic pegmatite (≤2-5 cm to ≤1-3 m) sheets with concordant or discordant rhyolite or granophyre seams (≤3 cm). The MFU (≤165 m) contains multiple (≤15-20), thin (≤15-20 m), geometrically complex flow sheets with abundant, zonally arranged vesicles, now zeolite occluded amygdules. Abundant field evidence (e.g. flow lobes, stacked lobes, vesicle zonation, flow architecture) suggests the MFU consists of inflated pahoehoe flow sheets with emplacement duration of individual flows occurring over weeks to decades. The UFU (≤150 m), apparently absent in some eastern parts of the mapped area, contains ≤30-40% mesostasis in a medium-grained, ophitic-textured host. This unit consists of one or two flow sheets and also has colonnade style, polygonal jointing (≤1 m). The lower 10-20 m of the UFU locally contain rhyolitic material (ca. 70-74 wt. % SiO_2) in the form of sills, dykes, amoeboid masses and spectacular segregation pipes (3-60 cm; 10-15/m^2) that are sometimes cored by agate and crystalline silica. The presence of many petrological oddities in the NMB has implications for magmatic processes (e.g. immiscibility) in basaltic systems, occurrence of granites in anorogenic settings, and even the probable occurrence of metal-rich hydrothermal plumes in once hydrous felsic magma chambers (i.e. porphyry systems), as will be discussed. All these volcanological wonders, exposed so abundantly by nature, makes the Jurassic North Mountain Basalt a paradise for preservation of ancient volcanic processes!

Mississippi Mourning: the Geological, Historical, Political and Cultural Ingredients of the Katrina Catastrophe - Why There is No "Big Easy Fix"

E. Kosters[1]

The Mississippi River is one of the world's largest rivers, draining most of the conterminous United States. Since the arrival of the first settlers in the 1500s, the river has been a major artery for trade and the region a rich fish, crop and later oil and gas producer. Millions of years of geological processes have resulted in the vast, immensely thick Mississippi Delta and its adjacent coastal regions. In addition, the Gulf of Mexico is a hurricane-prone region. These combined factors create an extremely vulnerable setting, convincingly demonstrated by extensive federal- and state-funded research during the past few decades. Louisiana decision makers have, therefore, known for a long time that, despite an array of land management practices implemented over the centuries, they were sitting on a time bomb ticking away to an unknown Time Zero. Unique historical, political and cultural elements have contributed to unsustainable management, administrative paralysis and lack of proper mitigation measures. The catastrophe leads many to ask what the exact ingredients for this disaster are and why other countries seem to manage their coastlines better than the Gulf of Mexico States. The lecture aims to show that the situation is hugely complex, both physically and from a human perspective, and that there is currently no Big Easy Fix.

Free will donations will be accepted to assist schools in Baton Rouge purchase uniforms for their suddenly doubled population.

Dr. Elisabeth Kosters is a geologist and was a team member of the Coastal Geology Program of the Louisiana Geological Survey from 1981 to 1986.

[1]Geology Department, Acadia University, Wolfville, NS B4P 2R6

Current Activities in Geological Mapping and Geochemistry

M. A. MacDonald, T. A. Goodwin, R. J. Horne, R. D. Naylor, R. R. Stea and C. E. White

Geoscientists in the Geological Mapping and Geochemistry Section were active in several projects in 2005. Specific activities include the following.

Terry Goodwin conducted a limited field program with DNR geologist Paul Smith, as part of his on-going participation in the Metals in the Environment (MITE) program, a multi-disciplinary project initiated by the Geological Survey of Canada (GSC) to examine metals and metalloids in the environments associated with past-producing gold districts throughout Nova Scotia (cf. Parsons *et al.*, p. 19).

Rick Horne completed bedrock geological mapping of Meguma Group rocks in map area 11D/13 (Mount Uniacke), along with DNR geologist Bob Ryan. Mapping was directed at acquiring data for gaps in coverage and to resolve questions of stratigraphy and structure. Rick focused on the location of fold hinges, distribution of stratigraphic units and characteristics of fold profiles to assist in preparation of a cross section. During the 2005 field season, Rick initiated a bedrock geological traverse across the Meguma Terrane north of Sheet Harbor to assist in the compilation of geology of the Eastern Shore region.

Rob Naylor and Dawson Brisco worked closely with the GIS Group and NRCan geologist Peter Giles to complete the bedrock geology maps for areas 11E/06 (Truro area) and 11E/07 (Hopewell area). This work represented the Nova Scotia component of the 2003-2005 Targeted Geoscience Initiative (Phase 2), a project designed to assist and promote mineral and energy exploration. Geological mapping was completed during the 2004 field season and the ensuing work includes the incorporation of digitally compiled historic geological information, mineral deposit research, geophysical modelling and regional geochemistry. Bedrock geological maps will be released in the fall of 2005.

Ralph Stea was approached by the Confederacy of MainLand Mi'kmaq to be a scientific advisor for the Debert project, a regional and detailed geological and archaeological mapping project designed to study the Debert Paleo-Indian site and surrounding lowland areas near Truro. Ralph's main contribution to the project is the three-dimensional surficial mapping of the study area. The project also included setting up a GIS system, including the compilation of numerous data layers including: coastal zone maps with hydrography, aggregate surficial geology maps, pertinent historical aerial photography, bedrock geological maps, biophysical information, soil series maps, and Crown land information.

Chris White continued 1:10 000 scale bedrock mapping in the South Shore region, resulting in the completion of 21A/02 (Liverpool) and 21A/03 (Lake Rossignal) sheets. Additional work included investigation of Zn and Cu mineralization from glacial outwash in Wedgeport gravel pits aimed at establishing the source area. Chris also worked with two B.Sc. Honours students, including Virginia Brake from Dalhousie University who is studying the geophysical characteristics of granitoid plutons in Southwestern Nova Scotia. The other student is Ryan Toole from Acadia who is looking at whole-rock chemistry from three stratigraphic sections through the Meguma Group in southern Nova Scotia to characterize the source area as Africa or some other peri-Gondwana terrane.

Drift Exploration Using Indicator Minerals and Till Geochemistry

M. B. McClenaghan

Drift prospecting in glaciated terrain encompasses a broad range of sample media, including boulders, till, stream sediments, soils and vegetation. The focus of this talk is the application of till geochemistry, indicator minerals and boulder tracing methods to exploration in the glaciated terrain of Canada. Glaciation has dispersed metal-rich debris from mineralized rocks tens of metres to tens of kilometres down-ice, forming dispersal trains or fans which are often much larger exploration targets relative to their bedrock source. Boulder tracing, till geochemistry and indicator mineral methods are used to detect these dispersal trains and can be used to explore for a broad range of commodities, including gold, PGEs, base metals, tin, tungsten, REEs, uranium and diamonds. Over the past 50 years, the application of these methods in Canada has contributed to numerous significant discoveries, including the Strange Lake REE deposit, the Steep Rock iron ore mine, the uranium deposits at Key Lake, gold deposits at Casa Berardi, the Buchans Zn-Pb-Cu deposit, and the highly diamondiferous kimberlites at Lac de Gras. Examples of glacial dispersal patterns associated with a variety of mineral deposits, with emphasis on eastern Canada, will be discussed.

[1]Geological Survey of Canada, 601 Booth St., Ottawa, ON K1A 0E8

Preliminary Assessment of Tills at Kemptville, Yarmouth County, and Moose River and Lake Catcha, Halifax County, as Placer Gold Ore Sources

R. F. Mills and J. D. Chipman

Following assessment of till material as a possible source of placer gold in 2004 at Tangier, Nova Scotia, preliminary assessment of tills at several Nova Scotian sites took place during the 2005 field season. These sites were the Lake Catcha and Moose River gold districts, Halifax County, and the Kemptville gold district, Yarmouth County. For these three sites, it was decided to take relatively large samples, consisting of as close to 5 cubic metres as possible, and concentrate them in a sluice on-site. In each case, a sample of 4.8 cubic metres was taken. A Long-Tom sluice consisting of a 0.5 m wide by 3 m long run lined with v-ribbed rubber matting underlying three sizes of expanded metal, 1 m long each, lying end to end, concentrated the samples. The sluice was set up with a rise to run aspect of 7.5 cm/m and a water flow of 50 gal./min. Head and tailings samples were taken as well as sluiced concentrates.

At Lake Catcha, the sample site did not access the local (Beaver River) till and sampled a hybrid till with some aspects of the Beaver River till but consisting mainly of the more foreign Lawrencetown till. The sample was taken over known, well enriched veins, yet there was little quartz material on the oversize spoilage and little colour returned in the sluice. This is still considered to be a good site for further evaluation, if a more localized till can be accessed at the site.

The other sample sites were more successful. At Kemptville, the sample was taken from a source previously sampled and known to return gold. On analysis the site returned a head grade of almost 0.5 gram/ton (490 ppb) in a thick, volumous till. This site lies close to several known gold-producing quartz veins, which exist within a massive shear zone transecting the Kemptville gold district. On preliminary inspection, this site appears to be ore-grade placer material. Preliminary work is progressing at the site to determine further grades and volumes.

Till at Moose River was sampled close to the Moose River Touquoy pit. This pit was sampled in the 1980s close to zones worked by Touquoy in the 1880s. The overburden tested was originally stripped off the pit site when it was excavated. Touquoy described the till at Moose River as ore grade (approximately 2.5 grams/ton) and ran a successful test of it as well. It is believed the sample for the 2005 test came close to his original site. Visual inspection of gold returned in the sluice at clean-up revealed a very good return consisting of small delicate grains up to 0.5 cm long, many small sand sized and slightly larger nuggets, and flour gold in the rubber matting.

Further evaluation of the sites at Kemptville and Moose River will continue. Valuable placer deposits may exist at these sites. In the case of Moose River, the site is within the boundaries of a newly proposed open pit mine. Should this proposed development go forward, it is conceivable the mine's bottom line may increase with a small wash plant added to the mill circuit in order to exploit this resource, separating gold from overburden as the site is prepared for removal of bedrock.

A Summary of the Work Completed for the Nova Scotia Component of the 2003 to 2005 Targeted Geoscience Initiative Program

R. D. Naylor, D. C. Brisco and P. S. Giles

The Targeted Geoscience Initiative Program (TGI) is a national program designed to assist and promote mineral and energy exploration. The Nova Scotia component of the most recent TGI program (Phase 2) began during the summer of 2003 and work on the program has now been largely completed. Project work focused on bedrock mapping of the area covered by NTS sheets 11E/06 and 11E/07. The project also included mineral deposit research, geological resource evaluation, geophysical modelling, regional geochemistry and compilation of historical mapping data.

All the maps produced by this project were digitally compiled in an ArcView® format. The maps that are available include:

- GSC published and open file maps 1058a, 1215a, 3757, 3535 and 3703;
- twenty-one previously unpublished maps which formed part of the Nova Scotia Department of Mines St. Marys River Basin Project undertaken from 1968 to1971;
- four previously unpublished 1:50 000 scale maps illustrating the work undertaken as part of a NATMAP project in the St. Marys Basin by Brendan Murphy and Randy Rice (1993-94). These maps were released as Nova Scotia Department of Natural Resources, Mineral Resources Branch Open File Maps 2005-10, 11, 12 and 13;
- new 1:50 000 scale maps of NTS areas 11E/06 and 11E/07 created using new mapping carried out for this project and compiled data from previous workers;
- thirteen new 1:10 000 scale maps detailing the upper Carboniferous strata adjacent to the Cobequid Fault from Londonderry to Kemptown;
- 1:50 000 geophysical maps for the entire project area (aeromagnetic, gravity,VLF-EM);
- recent industry high-resolution airborne magnetic survey of parts of NTS areas 11E/06 and 11E/07; and
- colour/contoured shaded relief map images of the project area created from digital radiometric data acquired from Radiation Geophysics Section of the Geological Survey of Canada.

The mineral occurrence database for the project area has been updated and many of the more significant occurrences were re-visited. The results of the mineral deposit studies and regional geochemistry will be published in the Mineral Resources Branch Report of Activities for 2005.

Naturally Occurring Radionuclides in Nova Scotia's Rocks, Water and Air

G. A. O'Reilly

Few subjects catch the attention of the public more than radiation and radioactivity. The mere inference that radiation is an issue somewhere invokes an immediate, sometimes almost hysterical response that is sure to receive media attention. Nova Scotia has had its share of radiation issues involving elevated levels of radionuclides like uranium (U) and radon (Rn) in our waters and the air within our living spaces. These are naturally occurring phenomena and related to an interplay of bedrock geology with present-day, near-surface weathering conditions. They are not necessarily unique to our region.

Occurrences of uranium have been known in Nova Scotia since the early years of the 20th Century when pegmatites containing minor amounts of radioactive minerals were noted. During the 1950s, it was recognized that many of the sediment-hosted Cu deposits of the Carboniferous units in northern Nova Scotia also have anomalous levels of U and are typical 'roll front' deposits. The late 1970s saw a period of exploration for U deposits and recognition that the granites of our southern mainland host fracture-controlled, vein-type U deposits identical to those found in the similar granitic terrains of western Europe. Exploration also recognized the presence of minor U mineralization within reduced horizons at the base of the Carboniferous Windsor Group limestones and within Cambrian black shale units in southeast Cape Breton Island.

In 1978, elevated levels of U in well waters in the Harrietsfield area west of Halifax was recognized and the issue of the environmental and potential health impact of this phenomenon was first raised. Following the Harrietsfield recognition, a provincial government Uranium Task Force was formed that determined the levels of U, Ra and Rn in drinking water supplies in several selected regions of the province and found that elevated levels of U and Rn in groundwater is a naturally occurring phenomenon and widespread within some of our geological terrains, most notably the granites of the western mainland and the some of the Carboniferous sedimentary basins in Cumberland County.

Throughout the world, but particularly in the United States, the 1980s brought about an awareness that exposure to Rn in the air we breathe within our homes and work places is a significant contributor to non-smoking related lung cancers. Health Canada carried out a national survey of the level of Rn in air within buildings under their jurisdiction and found that several in the Ingonish Beach area had Rn levels well above the Health Canada guideline of 800 Bq/m^3. This recognition resulted in the province carrying out a reconnaissance testing of the air in homes in several regions known to be prone to elevated U and Rn in groundwater. Again, as with the Uranium Task Force findings in groundwater, it was found that elevated Rn in homes is a widespread phenomenon but is less directly correlative with geology.

In 2002, the province carried out environmental testing of Sir John A. MacDonald High School near Halifax in response to an abnormal number of complaints of illnesses among its students and staff. A total environmental screen of the school drinking water supply (drilled well) showed a level of Pb^{210} activity (a daughter radionuclide of the U^{238} decay series) exceeding the Guidelines for Canadian Drinking Water Quality limit of 0.1 Bq/l. The province formed a special advisory group on drinking water (SWAG) to examine this issue province-wide and recommend an appropriate course of action. As it turned out, Nova Scotia was the first jurisdiction world-wide to carry out such a comprehensive examination of the incidence of Pb^{210} in its water supplies, and SWAG found itself blazing the trail in determining how to evaluate the extent of the phenomenon. After two years of extensive sampling of a variety of water supply sources SWAG was able to conclude that, in fact, the anomalous level of Pb^{210} detected in the water is actually an artifact of using an inappropriate analytical testing method for the element. In reality, the elevated Pb^{210} levels noted were actually due to the water supplies in question having an initial high level of Rn, the U^{238} decay series daughter element from which Pb^{210} is derived.

Arsenic and Mercury Contamination from Historical Gold Mine Tailings in Nova Scotia

M. B. Parsons[1], P. K. Smith, T. A. Goodwin, G. E. M. Hall[2] and J. B. Percival[2]

Historical stamp milling and Hg amalgamation activities at lode-gold mines in southern Nova Scotia have generated more than 3 million tonnes of tailings. From 1861 to the mid-1940s, gold was mined in 64 districts throughout the Meguma Terrane, resulting in a total production of 1.2 million oz. (37 tonnes) of gold. Most of this gold was recovered using Hg amalgamation, and an estimated 10-25% of the Hg used was lost to the tailings and to the atmosphere. In addition to Hg added during the milling process, toxic metal(oid)s (primarily As) also occur naturally in the ore, and are present at high concentrations in the mine wastes. Tailings from these early operations were generally slurried into local rivers, swamps, lakes, and the ocean with little or no consideration of their impacts on receiving environments.

This study is a multi-disciplinary, multi-partner investigation of the dispersion, transformation, and fate of metals and metalloids in freshwater and marine environments surrounding abandoned gold mines in Nova Scotia. From 2003 to 2005, samples of tailings, soil, till, rock, sediment, water, and/or vegetation were collected at 15 past-producing gold mines. Field studies reveal that most mine sites contain large volumes of unconfined tailings, which are generally located in low-lying areas downslope of stamp mill sites. In some districts (e.g. Goldenville, Upper/Lower Seal Harbour) the tailings have been transported significant distances (>2 km) offsite by local streams and rivers. At most mines, the tailings are overgrown and often difficult to recognize; however, some tailings deposits have recently been disturbed by human activities (e.g. gold panning, fill excavation, off-road vehicle usage).

Whole-rock chemical analysis of unmineralized Meguma Group bedrock away from lode-gold deposits suggests background levels for Hg and As to be ~3 ppb and <5 ppm, respectively. Within gold districts, however, concentrations for Hg and As in the ore zones average ~50 ppb and ~1 000 ppm, respectively. Chemical analyses of 433 tailings and downstream sediment samples show high concentrations of Hg (<5 ppb to 350 ppm; mean 7 ppm) and As (9 ppm to 31 wt.%; mean 1 wt.%). The highest Hg levels are found near mill structures, reflecting Hg loss during amalgamation and retorting. Droplets of elemental Hg and particles of amalgam (Au_xHg_x) have been observed in the tailings at several locations; however, Hg may also exist in secondary phases (e.g. metacinnabar, HgS), or may be sorbed to mineral surfaces and/or organic material. Arsenic concentrations >1 wt.% (measured in ~22% of all tailings/sediment samples) are generally restricted to areas where arsenopyrite (FeAsS) concentrates are present, or where weathering of the tailings has concentrated As in secondary phases such as scorodite ($Fe^{III}AsO_4 \cdot 2H_2O$). Water chemistry data indicate that dissolved As concentrations are very high at some locations (0.2 to 6600 ppb; mean 390 ppb; $n = 122$), as compared to background levels of generally <25 ppb. Dissolved Hg levels range from 1 to 60 ppt (mean 13 ppt; $n = 122$), and show a significant positive correlation with dissolved organic carbon at most sites. In general, the dissolved Hg concentrations in surface waters are relatively low (i.e. <20 ppt) even close to tailings with high (i.e. >1000 ppm) levels of Hg, suggesting that most of the Hg is present in relatively insoluble forms.

Ongoing studies by the authors and other project partners are characterizing the background levels, seasonal variability, speciation, mobility, and bioaccumulation of metal(loid)s in both freshwater and marine systems. Results from this study have recently led to the formation of a provincial-federal Historic Gold Mines Advisory Committee (http://gov.ns.ca/enla/contaminatedsites/goldmines.asp). This committee is evaluating the potential ecological and human health risks associated with gold mines throughout Nova Scotia, and developing recommendations for management of these tailings sites.

[1]Geological Survey of Canada (Atlantic), Dartmouth, NS (Michael.Parsons@NRCan.gc.ca)
[2]Geological Survey of Canada (Northern Canada), Ottawa, ON

GIS Database Construction for the Annapolis Valley Aggregate Project

G. Prime

Geological conditions at the end of the last glacial episode resulted in the deposition of large amounts of sand and gravel in the Annapolis Valley and surrounding areas. Numerous ice-contact, proglacial and glaciomarine deposits are found in the lowland and coastal areas. The North Mountain and South Mountain upland areas also contain scattered mounds and ridges of ice-contact gravel. Collectively these glacial sediments have met the aggregate needs of the communities for many decades. However, the continual exploitation of the materials has depleted many deposits and exhausted others. Sand sources in the eastern end of the region have also come under additional pressure to satisfy the demand of the Halifax-Dartmouth area, which has no natural sand deposits. The coarse stone component of the resource is also being affected by industry changes. The recent tightening of construction materials standards has favoured the development of crushed stone quarry operations throughout the region. These large bedrock deposits generally offer a more consistent, higher quality product than most glacial gravels. However, locating deposits which contain high quality stone is a challenge. The vast majority of the bedrock geology in the region will not meet construction aggregate specifications.

The aggregate resource is also being affected by land-use issues. Residential and commercial development, for example, is continually encroaching on the resource land. Similarly, recreational uses of the land such as cottages and hiking trails are expanding into the remote areas where the resource potential still exists. Infrastructure developments such as highways, power transmission corridors and communications towers are also expanding in the region. Many of these land uses not only sterilize the aggregate potential of the underlying land but commonly affect much of the adjacent land as well. Resource development is also being affected by social and environmental concerns. Issues such as view planes, species at risk, nesting habitats and archeological findings will make much of the aggregate potential vulnerable to sterilization in the future.

Collectively these issues will have negative consequences for the region's aggregate resource in the future. The problems will include diminishing stone reserves and difficulties accessing new, high quality deposits. In order to gain a better understanding of the resource DNR conducted an assessment of the aggregate resource in Hants, Kings, Annapolis, Digby and Yarmouth counties. This mapping and materials analysis study has looked at all aspects of the sand, gravel and bedrock potential throughout the region. Currently the fieldwork for the project is finished and the resulting information is being compiled into a digital database. The finished product will include point and polygonal data, descriptive fields, resource maps, sample analyses and a photo record of the fieldwork. A report describing the findings of the research will be prepared as the final component of the study. During 2005, the construction of the database continued with the entry of point data, descriptive fields and analytical tables. The work was carried out by Megan Little with the assistance of Geoscience Information Services at DNR. Ultimately it is anticipated that the information will provide meaningful input into identifying solutions to the problems which will face the region's aggregate resource in the future.

The Legacy of Glacial Lakes in Nova Scotia

R. R. Stea

At the end of the last ice age a myriad of large lakes formed in the highland-rimmed valleys of Nova Scotia. Glacial Lake Shubenacadie covered more than 250 square kilometres in the Shubenacadie and Musquodoboit valleys and formed when a glacier occupied the Minas Basin, causing the water to back up into the southern valley and spill over into the chain of lakes that define the Shubenacadie canal system, eventually emptying into Halifax Harbour. Deposits of massive clay settled in the lake basins and sand and gravel deposits mark the lake shorelines. Glacial Lake Shubenacadie attained a maximum depth of 30 m, controlled by the elevation of the rock sill at Lake William, the highest lake along the Shubenacadie canal spillway. Glacial lakes also formed by a similar process in the Annapolis Valley (Glacial Lake Aldershot) and in the lowlands of southeast Cape Breton (Glacial Lake Dawson). The origin of the thick massive clay deposits within these basins is also enigmatic, as glacial lake deposits tend to have seasonal, melt-induced layering and ice-rafted debris. The lack of bedding can be explained by turbid mixing in relatively shallow lakes, and the lack of dropstones by relatively small and distant ice dams. The Younger Dryas, a still unexplained catastrophic cooling occurring about 13 000 years ago, caused glaciers to re-advance, and reform glacial lakes in some of the lowland basins.

At the turn of the Twentieth Century local glacial lake clays were utilized for brick making in many parts of Nova Scotia, but today they are used to make bricks only at Lantz, Nova Scotia. The homogeneity, plasticity and low-firing temperatures of Nova Scotia glacial lake clays make them an attractive raw material in a mix for brick and tile manufacture. Locally available sand and kaolin can be added to extend firing ranges and reduce shrinkage, producing a wide variety of structural clay products. Plastic Nova Scotia clays can be utilized in pottery, and in the production of clay "slips". The Department of Natural Resources and Dalhousie University are in the process of evaluating Nova Scotia clay for environmental liner and seal applications.

Characterization of Existing Sand Deposits in the Annapolis Valley Utilizing High-resolution LIDAR Digital Elevation Models

A. Templin[1] *and T. L. Webster*[*2]

The use of Light Detection and Ranging (LIDAR) data to characterize landforms associated with specific surficial aggregates is currently being investigated by the Applied Geomatics Research Group (AGRG), Centre of Geographic Sciences (COGS), Nova Scotia Community College. Traditional Digital Elevation Models (DEMs) produced from photogrammetry have limited resolution (ca. 20-50 m) and degraded accuracies (less than ± 2.5 m) in forested areas. The narrow laser beam of LIDAR systems allows penetration of the vegetation canopy and measurements of the ground to be made even in forested regions. The ability to remove the trees and anthropogeneric features allow bald-earth DEMs to highlight subtle geomorphic features. Different visual techniques are employed to produce colour shaded relief maps optimizing shading angles, perspective views and chromostereoscopy utilizing 2 m DEMs produced from airborne LIDAR data flown in the Annapolis Valley in May 2003. The LIDAR data are integrated with existing surficial geology maps in a GIS environment to refine these map products and better understand the formation of sand deposits.

[1]Intern
[2]Research Scientist, Applied Geomatics Research Group (AGRG), Centre of Geographic Sciences (COGS)
NSCC Annapolis Valley Campus, 50 Elliot Road, Lawrencetown, NS
*corresponding author timothy.webster@nscc.ca

Petrographic and Chemical Variations Through the Goldenville and Halifax Formations, Bear River, High Head, and Broad River Sections, Southwestern Nova Scotia

R. M. Toole[1], S. M. Barr[1] and C. E. White

The Meguma terrane of southern Nova Scotia is the most outboard terrane of the northern Appalachian orogen. It is characterized by the Meguma Group, made up of the Late Proterozoic(?) to Cambrian Goldenville Formation, which consists mainly of thickly bedded, massive metasandstone with minor interbedded metasiltstone and slate, and the conformably overlying Cambrian to Lower Ordovician Halifax Formation, composed mainly of slate with thin beds of metasiltstone and metasandstone. Although generally interpreted to have formed at a continental margin, whether that continent was Africa or some other peri-Gondwanan area is still debated.

Sedimentary rock geochemistry is a viable tool for regional correlation and provenance studies. During the summer of 2005, samples were collected from three relatively well exposed stratigraphic sections through the Goldenville and Halifax formations in the Bear River, High Head, and Broad River areas of the Meguma terrane. The purpose of this project is to compare petrographic and chemical data from these samples to look for systematic regional or stratigraphic variations in the Meguma Group. These data will be integrated with other available geological and geochronological data to interpret the depositional/tectonic setting and provenance of the sediments that now form the Meguma Group.

A total of 38 samples were collected, mainly metasiltstone and metasandstone but also including some slate samples. Twelve samples were collected over a section 12 000 m in stratigraphic thickness in the Bear River area, 13 samples over a section 7600 m in stratigraphic thickness in the High Head area, and 13 samples over a section 3200 m in stratigraphic thickness in the Broad River area. All three sections cross the Goldenville Formation - Halifax Formation contact. Documentation and interpretation of the petrography and chemistry of these samples will form the basis of the B.Sc. honours thesis of the first author.

[1]Department of Geology, Acadia University, Wolfville, NS B4P 2R6

Structure of the Western Cumberland Basin: Implications for Coalbed-methane Exploration

J. W. F. Waldron[1] and M. C. Rygel[2]

The Cumberland Basin of Nova Scotia, a large depocentre in the late Paleozoic Maritimes Basin, contains a Carboniferous succession that is probably more than 8 km thick. Previous hydrocarbon exploration has focused on anticlines cored by Mississippian Windsor and Mabou groups, with targets in the underlying Horton Group. New seismic profiles in the Cumberland Basin show reflectors that can be traced to surface, allowing correlation with surface mapping. The basin is currently a target of exploration for coalbed methane.

Subsidence and tectonism in the Cumberland Basin were clearly in part controlled by differential flow of Windsor Group evaporites, which may have begun as early as late Viséan time, and which continued intermittently through the Namurian and Pennsylvanian. Non-marine clastic units were deposited in synclinal minibasins, and abut against adjacent evaporites or are truncated beneath internal unconformities.

In the western part of the Cumberland Basin, known as the Athol Syncline, the Joggins Formation, famous for preserved upright fossil trees, thins conspicuously eastward onto an evaporite-cored antiform at Springhill. To the south, a transition in the character of reflectivity suggests a lateral facies change, and map relationships indicate that coal-bearing units interdigitate with conglomerates of the Polly Brook Formation. At depth, reflectors identified as representing the Namurian Mabou Group appear to rest directly on basal Windsor Group at an evaporite weld, indicating that the entire thickness of evaporites was evacuated, mainly during Pennsylvanian subsidence. Early Westphalian evaporite withdrawal is largely responsible for the great thickness of coal-bearing Cumberland Group strata.

Farther east, in the area of the Tatamagouche syncline, a much thinner Cumberland Group overlies the Mabou Group with clear angular unconformity. Traced to depth, the Mabou also thickens into a synclinal minibasin, which subsided into evaporite-bearing Windsor Group. The Cumberland Group succession is much thinner in this area, and lacks the thick coals present in the west. This is probably because evaporite withdrawal occurred earlier, during Namurian time.

These relationships suggest a tectonic history in which initial evaporite movement was triggered in the eastern basin by transtension along the north edge of the Cobequid Highlands, which is aligned east-west in this area. A subsequent change in the relative motion on basin-bounding faults led to overthrusting in the eastern Cumberland Basin, and initiated evaporite withdrawal in the Athol Syncline. The tectonic history has a major influence on the distribution of coal-bearing units, and is a significant factor in coalbed-methane exploration.

[1]Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB T6G 2E3, Canada
[2]Department of Geosciences, 214 Bessy Hall, University of Nebraska-Lincoln, Lincoln, Nebraska 68588-0340

The Application of High-resolution LIDAR Elevation Models for Understanding Landscape Evolution: an Example from the North Mountain, Nova Scotia

T. L. Webster[1]

A high-resolution laser altimetry (LIDAR) digital elevation model (DEM) is applied to geological problems related to bedrock and surficial mapping and the relationship to earth-surface processes, including fluvial incision and surface runoff, in a region of the North Mountain in Nova Scotia. The LIDAR data are validated using GPS and traditional survey methods under the forest canopy. The LIDAR DEM has been used to map three flow units with contrasting physical and chemical characteristics, and previously unidentified craters within the Jurassic North Mountain Basalt Formation. Field investigations confirm the contacts identified from the DEM. Petrographic analysis of samples collected on transects across the craters indicates the crater rims are composed of quenched lava. The craters are interpreted to be a result of the interaction between partially solidified lava and surface or shallow groundwater. Morphometry has been calculated from the DEM for basins draining into the Bay of Fundy from the adjacent North Mountain that were formed by fluvial incision, modified by glaciation and subsequently by fluvial processes. Stream longitudinal profiles have been extracted and used with drainage divides to determine stream incision depths, which are then related to the different flow units of the NMB. The variable resistance of the flow units to erosion by abrasion and plucking was tested in the laboratory using a shatterbox and the fracture density was estimated from drill core. The variable resistance to erosion of the three flow units controls the amount of incision that occurs within the streambed. Hydrographs and water chemistry parameters measured in two basins with different glacial till cover thickness indicate that the thick till promotes surface run-off and retards infiltration, thus increasing the stream's ability to incise. Several wave-cut terraces have been measured along the coastline in the thick till blanket areas. This paper demonstrates through a range of examples that the precision and enhanced resolution of LIDAR can improve our understanding of how landscapes form and evolve.

[1]Research Scientist, Applied Geomatics Research Group, Nova Scotia Community College, Middleton, NS
Email: timothy.webster@nscc.ca

Preliminary Bedrock Geology of the Liverpool and Lake Rossignol Map Areas (NTS 21A/02 and 21A/03), Southern Nova Scotia

C. E. White and R. M. Toole[1]

The second year of the South Shore Nova Bedrock Mapping Project focused on completion of the Liverpool and Lake Rossignol map area
s (NTS 21A/02 and 21A/03, respectively) in southern Nova Scotia. The main objectives of the 2005 map season were to: (1) produce two 1:50 000 scale geological bedrock maps, (2) attempt a stratigraphic subdivision of the Meguma Group and (3) comment on the economic potential of the area.

The oldest units are the Cambrian to Early Ordovician Goldenville and Halifax formations. The two-part subdivision of the Goldenville Formation recognized in the previous map areas to the south and southwest is continued into the 2005 map area. However, an intervening middle unit is recognized in the eastern part of area. The lower unit is thickly bedded, massive, grey metasandstone interbedded with laminated metasandstone, minor metasiltstone and rare black slate. This unit displays a featureless aeromagnetic signature. In the eastern part of the 2005 map area, this lower unit is overlain by a unit of regularly bedded, grey metasandstone and minor metasiltstone which contrasts with the lower unit in displaying a distinct, relatively high aeromagnetic pattern. The upper unit consists of massive to well laminated grey metasandstone at the base and fines upwards into dominantly green metasiltstone and slate with thin metasandstone beds. The metasandstone beds typically display cross-stratification. The upper 50 m of this unit locally contains thin pink coticule beds. Although the lower part of this unit has a featureless aeromagnetic signature, the metasiltstone-dominated upper part displays two distinct aeromagnetic bands that can be traced on a regional scale. Calc-silicate nodules and beds are common throughout the Goldenville Formation. Grazing and burrowing trace fossils were observed in the upper unit but have not yet been assigned an age. The overlying Halifax Formation consists of black slate and metasiltstone, interbedded locally with pyrite- and arsenopyrite-rich beds. The contact with the underlying Goldenville Formation is sharp and conformable.

The Meguma Group is intruded by the 380-373 Ma South Mountain Batholith, Bald Mountain Pluton and Port Mouton Pluton. In the map area they consist of medium- to coarse-grained, biotite- and muscovite-bearing monzogranite. The Bald Mountain Pluton previously was mapped as one body but based on aeromagnetic data it is now interpreted to consist of several smaller stocks. The South Mountain Batholith and Bald Mountain Pluton contain abundant xenoliths of metasedimentary rocks, and have well developed contact metamorphic aureoles.

The Meguma Group in the map area, as elsewhere, is deformed into regional, northeast-trending F_1 folds with a well developed axial planar cleavage, produced during the Devonian Acadian Orogeny. Intersection lineations (L_1) plunge gently to the northeast and southwest. Deformation was accompanied by greenschist-facies (biotite-grade) metamorphism. The Early Jurassic Shelburne Dyke is poorly exposed, but based on its distinctive aeromagnetic signature can be traced through the map area.

Several past-producing gold districts occur in the Liverpool - Lake Rossignol map area, where bedding-parallel quartz veins in the Goldenville Formation are gold-bearing. In addition, gold-bearing quartz clasts and free gold have been discovered in thick till that covers most of the area. Close to the contact with the South Mountain Batholith, several breccia outcrops in the Goldenville Formation and boulders of metasandstone contain significant galena and sphalerite. The Goldenville Formation hosts one operating aggregate quarry, and several gravel and sand pits are currently being used. The area has potential for other aggregate and sand/gravel deposits.

[1]Department of Geology, Acadia University, Wolfville, NS B4P 2R6